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ART. I.—*Microscopic Researches, relating to the Histology and Minute Anatomy of the Spleen and Lacteal and Lymphatic Glands; showing their Ultimate Structure and their Organic Elements, and their Highly Interesting and Important Functions; with some Remarks on the Cause of the Ropiness of Mucus, and the tendency of all Healthy and many Diseased Cells to be Metamorphosed into filaments.* By J. H. SALISBURY, M. D., Prof. of Histology, Physiology, and Pathology in Charity Hospital Medical College. (With a plate.)

Previous Knowledge of the Spleen.—Although much has been said from time to time by both ancient and modern writers, concerning the minute structure, organic elements, and functions of the spleen, yet really little has been positively determined relating to the important parts of either. No organ in the human body has excited—in all ages of medical science—more interest, and none have yielded to the inquirer less satisfactory results. It is an extremely difficult organ to investigate, from the fact of its exceeding vascularity, and the great amount of cell, filamentous and liquid products which are constantly being organized, and undergoing in it the processes of morphological transformation and assimilation. It is supplied abundantly with blood by branches of the coeliac axis. Its veins converge, coalesce, and empty their contents into the great portal system which conducts the blood products of the spleen into the liver. The spleen is enveloped in a strong close fibrous membrane of considerable vascularity and elasticity, and intimately adherent externally to the peritoneum, and internally to its parenchyma. This fibrous investment at the hilus of the organ is reflected upon its vessels in all their ramifications, forming an elastic areolar framework which binds together the loose portions of the organ.

From the investing sheaths of the vessels, as well as from the fibrous investment, numerous small fibrous trabeculae or bands are given off in all directions; these uniting constitute the areolar framework of the organ. This areolar framework is made up of white and yellow elastic fibrous tissue, the latter considerably predominating. What is called the pulp of the spleen occupies the interspaces of the areolar framework.

Its parenchyma consists of a sort of corpus cavernosum, the trabeculae of which, fibrous in nature, are continuous by their extremities with the fibrous sheaths of the vessels and inner surface of the proper coat of the organ, and in the interspaces is a soft material very closely resembling blood clot, known as the pulp of the spleen. One important fact was early noticed, that the efferent bloodvessels were much larger than the afferent. Another interesting observation was made by Dr. Dobson,¹ that the size of the spleen increased from the third hour after feeding up to the fifth, after which it gradually decreased to its normal quiescent size, which it retained till the next feeding.

Malpighi discovered, in what has been called the "splenic pulp" of the spleen, numerous whitish globular bodies, which have been termed the Malpighian bodies in honour of their discoverer. These were noticed to be attached to the side or at the point of bifurcation of some small artery. They are described as consisting of a closed sac or capsule, containing in its interior a viscid semi-solid mass of cells, cell nuclei, and homogeneous substance. Each Malpighian body has been observed by Kölliker, Burk, Huxley, and others to be penetrated by capillaries, and to be covered on its exterior by a fine capillary network. Leydig regards them as analogous to lymphatic glands, and considers them as really minute lymphatic glands in the spleen.

A very interesting fact with regard to this gland is that it has been entirely removed from dogs, cats, and other animals without its loss producing serious permanent injury. The most constant and permanent effect of its removal is an unusual increase in the appetite; the animals devouring ravenously, and in unusual quantity, any kind of food offered, even that which they would not touch in their normal state.

The food had been noticed to digest well and the animals to increase in weight, the hair becoming unusually sleek and glossy. Another symptom which generally follows the removal of the spleen is an unnatural ferocity of disposition.

From these facts it has been inferred that the spleen is not a single organ, but is associated with other (lymphatic) glands, which may to a greater or less extent perform its functions after its removal. This is believed to be rendered probable from the fact that after the removal of the spleen, the lymphatic glands of the neighbourhood invariably become very

¹ Gray on the Structure and Use of the Spleen. London, 1854. p. 40.

much enlarged and clustered together, so as nearly to equal the original spleen in volume.

Otto Funke, Professor of Physiology at Freiburg, conveys the idea, in his *Atlas of Physiological Chemistry*, that in the splenic pulp, in large cells, the formation of red globules seems to take place by endogenous vegetation.

Kölliker asserts, on the contrary, that these cells are at first nothing more than aggregations of red globules around which a membrane has formed, thus constituting a cell of which these old blood globules become the nuclei, and that they are about to undergo still farther metamorphosis in a retrograde direction. Otto Funke holds that the spleen forms blood disks, while Kölliker, on the contrary, asserts that it destroys them.

C. Morel, Professor at Strasburg, in his recent work on Histology, says the splenic pulp, the substance of which is traversed by the finest vessels and the most delicate trabeculæ, includes elements of different kinds. Its principal bulk consists of cells similar to those of the Malpighian corpuscles, debris of red blood corpuscles, blood pigment, and large cells with many nuclei, $\frac{1}{8}$ to $\frac{1}{6}$ of a line in diameter, make up the remainder. He further says, it is a matter of extreme difficulty to determine the relations which exist between the splenic pulp and the larger veins of the organ. Is the pulp entirely outside of the vessels as asserted by some authorities, or are the spaces in which it is contained simply dilatations of the veins, and if this be true, does it form a part of the general circulation? The researches which seem to us most conclusive tend rather to establish the entire independence of the cavities which contain the splenic pulp, yet the fact is not to be accepted as demonstrated. Gray has written at length upon the spleen, and has in his work on this subject many observations that have an interesting and important bearing upon the true structure and functions of this organ, yet without really comprehending its important office, or being aware of the existence of really the most interesting parts of its structure.

Kölliker, in his *Microscopic Anatomy*, pp. 559-60, comes to the conclusion that the spleen appears to be an organ which develops blood corpuscles, and aids perhaps in forming bile. He is also led to believe that the formation of blood corpuscles in the spleen is an abnormal process, as they are not found in the bloodvessels, but in *aneurismatic spurias*.

He further is led to adopt the view that blood disks are disintegrated in the spleen.

Rémak thinks that no cells are found in the spleen which contain blood disks, and no blood corpuscles are destroyed in the gland.

Virchow is satisfied of the existence in the spleen of cells containing blood disks. He believes, however, that the blood disks pass from without into existing cells.

Leydig describes a vascular network which penetrates the interior of the Malpighian bodies, and regards these corpuscles as minute lymphatic glands in the spleen.

The foregoing is a brief statement of all, we believe, that is at present positively known and published concerning the minute structure and functions of this interesting organ. I have presented it without any remarks of my own, or any statement connected with the results of my own investigations. From it will be seen the really imperfect and uncertain character of our knowledge of the spleen. From this imperfect knowledge of the organ, it has been inferred :—

1. That the spleen is a glandular organ analogous to other glands of the body that have no excretory ducts, and that it should be classed with the blood glands.

2. That it is the function of the spleen to modify the constitution of the blood, but what this modification is has not yet been determined.¹

This, without further knowledge of a positive character, conveys but little information which is really useful, as a diagnostic aid in pathological conditions, and throws but small light upon the histology and functions of that organ. Taken, however, with the following investigations connected with its newly-discovered elements and functions, they become highly interesting and valuable.

Investigations to determine the Weight of the Spleen as compared with that of the Body.—1. A robust, healthy female, aged 36, and weighing 135 lbs., who died a few days after the accident of burns on the back and side caused by her clothing taking fire :—

Weight of spleen, which was healthy	2,400 grains
Weight of kidneys	4,890 “

2. In a man, aged about 40, in perfect health and in good condition, shot dead in a recruiting office at Cleveland, Ohio, December 31, 1864, we have the following results :—

Weight of body	160 lbs.
Weight of liver	3 lbs. 2 $\frac{3}{4}$ 5 $\frac{3}{4}$
Weight of kidneys	10 $\frac{3}{4}$ 155 grs.
Weight of spleen	5 $\frac{3}{4}$ 25 “

3. Dog, male, was shot while in good condition :—

Weight of body	42 lbs.
Weight of spleen	1,920 grs.
Weight of liver	14,400 “
Weight of kidneys	2,880 “
Weight of testicles	472 “

¹ Brig.-Gen. Hammond, former Surg.-Gen. U. S. A., informs me since this paper was written, that he has an extended series of investigations connected with the spleen in the human subject, and in a great variety of animals, in which much that is new concerning this interesting gland is developed. Not having had the opportunity of seeing his interesting paper and extended illustrations, I regret that I am unable here to refer to the new developments he has made connected with the structure, histology, and functions of this interesting and important organ.

4. Large gray rat, male, good condition :—

Weight of body	15,360 grains
Weight of spleen	120 “
Weight of kidneys	40 “

5. Raccoon (*Procyon lator*), male; killed in January; good condition :—

Weight of body	9½ lbs.
Weight of spleen	297 grains

6. Young game cock, nine months old :—

Weight of body	30,720 grains
Weight of spleen	34.16 “
Weight of kidneys	40.39 “

7. Four game chickens, three months old :—

Weight of the four bodies	46,080 grains
Weight of the four spleens	44 “
Weight of the four livers	1,224 “

8. Snapping turtle (*Chelonuria serpentaria*) :—

Weight of body	32,640 grains
Weight of spleen	88 “

From the foregoing results the weight of the spleen, as compared with that of the body, is as the following numbers :—

Human (female)	1 to 432
Human (male)	1 to 506.72
Dog	1 to 161
Gray rat	1 to 128
Raccoon	1 to 145.6
Young cock	1 to 899
Young game chicken	1 to 1,049
Snapping turtle	1 to 371

Weight of the liver as compared with that of the body :—

Human (male)	1 to 50.57
Dog	1 to 22.4
Four chickens	1 to 37

Weight of the kidneys as compared with that of the body :—

Human (female)	1 to 212
Human (male)	1 to 248
Dog	1 to 112
Rat	1 to 384
Cock	1 to 758½

In proportion to the weight of the body, the spleen is larger in mammals than in birds, reptiles, and fishes.

In mammals the spleen is placed close to the left end of the stomach. In birds, reptiles, and fishes, the spleen is not only smaller, but firmer and more rounded, and is usually in them further removed from the stomach,

and placed in the midst of the mesentery, where it appears to perform, to a considerable extent, in addition to its office in mammals, the functions of a lacteal system.¹

In such animals the spleen is filled with Malpighian bodies which are plainly visible; while in most mammals, and especially in all such as are well supplied with mesenteric glands, the Malpighian bodies are seldom met with, especially in mature animals, or in the human subject; and when they are found, they are extremely faint in outline. This renders the views of Leydig highly probable that they are really lymphatic glands in the spleen, or, what appears to be more probable, bodies which take the place of the mesenteric or lacteal glands of mammals.

Occasionally an instance is met with in the human subject where the spleen is said to have been found rich in Malpighian bodies; this, however, must be quite unusual, as in all my examinations I never have met with an instance of this kind. It would be interesting in such cases to determine whether the mesenteric glands are not wanting, or abnormal, and to obtain as accurate histories as possible of the digestive peculiarities of the individuals during their healthy existence.

In the human subject, in old age, the spleen not only decreases in weight, but decreases considerably in proportion to the entire body, being as 1 to 700, usually.

In intermittent fever it becomes generally more or less enlarged. In some cases it attains the enormous weight of 18 to 20 lbs.

Structure of Spleen.—The spleen is made up of the following anatomical elements :—

1st. A fibrous tissue forming externally its investing envelope, adherent externally to the peritoneum, and internally to its parenchyma. At the hilus of the organ, it is reflected upon its vessels, and, accompanying them into its interior, forms a sort of capsule of Glisson. This fibrous envelope and capsule sends off bands and bundles of fibres to all parts of the organ, interlacing and uniting with each other and with the arterial trunks, forming numerous trabeculæ and a complete fibrous framework of considerable elasticity, which binds all parts of the spleen securely together.

2d. An artery which divides and subdivides, distributing its numerous large and thick-walled branches to all parts of the organ, and which are securely held in position by fibrous bands and bundles, which inosculate with those of the external arterial walls.

3d. A vein of unusual size formed by branches converging from all parts of the organ, and which forms an important branch of the portal vein.

4th. An extended plexus of thin-walled capillaries which connect the

¹ In birds, reptiles, and fishes, there appears to be but little appearance of a lacteal system, like that of mammals. The mesenteric glands are almost totally wanting.

arterial and venous extremities, and which often, by their divergence and convergence, form ovoid masses or bodies which connect one arterial extremity with the beginning of a venous branch.

5th. *Tubular glandules*, which are the arterial terminations, and which are lined with peculiar glandular cells that form and set at liberty the transparent thin-walled cells from which are developed cells that subsequently become transformed into fibrin filaments. These *tubular glandules* are numerous, and have very thick, strong, and highly elastic walls.

6th. *Oval splenic bodies (so-called splenic cells)*.

7th. Malpighian bodies, which are connected with the sides, bifurcation of, and extremities of arteries. They are more or less globular in form, and are made up of an external fibrous envelope formed by the expanded external arterial wall, forming a sac, in which are parent glandular cells that organize cells like those developed by the tubular glandules. In addition to this they develop in the human subject, in most other mammals, and in birds, yellow pigment, with rather a reddish tint; and in the reptiliæ and many fishes, a dark-coloured pigment, like that which is seen in the human spleen in the disease known as melanosis. These bodies are connected with the arteries also by capillary vessels, which pass around and abundantly through them.

In a few instances in birds, I have found these bodies terminating a minute arterial extremity, in which case they form a fibrous ovoid head; and are usually smaller than those attached to the sides and bifurcations of arteries. The internal arterial wall subdivides within into numerous radiating capillaries, which pass out of the body in every direction, like the radiating branches of a tree. The Malpighian bodies appear to perform the functions of mesenteric or lacteal glands, and, in addition, organize pigment cells which are usually in mammals of a yellowish or orange colour.

8th. *Amyloid glandules*. These are made up of a meshwork of highly refractive, pearly, capillary vessels, which communicate with the blood stream.

9th. *Nerves and lymphatics*. The lymphatics take their rise from the whole surface of the spleen, and communicate with the thoracic duct. The nerves are derived from the right and left semilunar ganglia and right pneumogastric nerve, and are small and form a slender splenic plexus surrounding the artery and entering the spleen with its branches.

The spleen is remarkable for the size of its artery, which is larger in proportion to the organ than in any other instance. The hepatic artery is rather larger than the splenic in young subjects; but in adults smaller; yet the liver in the latter is from five to seven times the size of the spleen. The splenic arterial branches are also remarkably and universally large, elastic, and thick-walled, when compared with the main trunk, indicating that they are designed for important functions. The arterial terminations are noticed to be lined with a peculiarly thick glandular epithelium, the outside cell wall

of which is more or less doubly fusiform or tapering each way from the centre. In the centre is a large, highly refractive nucleus varying greatly in size and shape, according to the rapidity of the organizing processes going on in the cell. The splenic vein constitutes one of the principal trunks of the portal vein. Although the splenic artery is very large, the splenic vein is still larger. In a child three months old, according to Haller, the artery measured twelve hundredths of an inch, the vein fifteen hundredths.

In a child eighteen months old the numbers were thirteen and nineteen. At three years old, fourteen and twenty-six. According to Sir E. Home, the trunk of the splenic vein compared with that of the artery, when both were filled with wax, is found to be in the proportion of five to one in its size.

Arterial Terminations.—The arterial subdivisions all terminate in one of four ways, viz :—

1. In *tubular glandules* followed by simple capillaries.
2. In tubular glandules followed by the oval splenic bodies (*i*, Pl. I.).
3. In Malpighian bodies (rare) in which the internal coat subdivides into radiating capillaries (*h*, Pl. I.).
4. In capillaries direct without the intervention of tubular glandules.

The most usual termination is in *tubular glandules*, followed by the *oval splenic bodies*. When the arteries terminate in tubular glandules followed by simple capillaries, their walls become very much thickened and highly elastic. This thickening is entirely in the external wall and in the lining epithelium. These terminate suddenly in a blunt oval extremity; while the internal tunic passes on, dividing frequently and forming thin-walled and highly elastic capillaries into which the fibrin cells organized in the tubular glandules pass, and are then partially transformed into filaments before reaching the veins. This is not a common mode of arterial termination. The large nuclei of the parent cells of the epithelial lining of the tubular glandules are exceedingly transparent and highly refractive; so much so, that they are with difficulty traced. These, when carefully examined immediately after death, have either a spherical or oval form, according to the degree of their distension. It is very difficult, however, to trace their true outlines. Their walls are highly elastic. When actively engaged in their functions, they are capable of considerable distension.

The nucleus is usually more plainly visible than the walls of the parent cell. The peculiar function of this epithelium is to organize a large, and at first exceedingly transparent and highly refractive bladder-like cell (*y*, Pl. I.), the envelope of which is so thin, delicate, and pliable, that it has more the appearance of a globule without cell walls than of a cell. It is to all appearance, at first, entirely destitute of any visible contents. Its walls, however, soon become more and more firm, a central nucleus appears which gradually grows more and more evident, and this soon is surrounded

by little globules (which are called granules). We now have before us the colourless corpuscle of the blood (*n*, Pl. I.), or really a *fibrin cell*, or a cell that becomes transformed into filamentous products; for as soon as it enters the extended plexus of elastic thin-walled capillaries, it hugs and sticks to the wall of the vessel, creeping along slowly, and as soon as mature sends out a thin hair-like process which continues to elongate as the cell slowly progresses, and finally is transformed, all but the nucleus, into an exceedingly fine and highly transparent and friable fibrin thread. The central nucleus when it escapes is irregular in outline, with its walls more or less flattened and folded. This takes up hematine and a highly plastic fluid; becomes smooth, highly refractive, and distended, and forms the blood disk.

When the arteries terminate in *tubular glandules* followed by the *oval splenic bodies*, the fibrous coat of the *tubular glandules* suddenly expands into an oval head, or large thin-walled oval sac, which is highly elastic (*i*, Pl. I.). The inside layer of the tubular glandule (*i*) as it enters the oval splenic body, sends off on every side diverging branches, like the radiating branches of a tree, of thin-walled elastic capillaries, which again converge in the farther half of the sac, coalesce with the central main vessel, and form as they leave the *oval splenic body* a venal branch of the splenic vein (*j*, Pl. I.). The fibrin cells which are formed in the tubular glandules (see at *i*, Pl. I.) hug the wall of the main vessel, as they enter the oval splenic body, creeping slowly along, and as they come up with the mouths of the radiating capillary branches,¹ they pass into them, while the red globules and serum keep mostly the centre of the central vessel, and pass directly through the oval splenic body into the venal branch.

The fibrin cells, however, clog up and distend the radiating capillaries, so that the oval splenic bodies, during rapid digestion and organization, become distended, causing the bulk of the spleen to increase.

These fibrin cells, during their slow-creeping passage through these thin-walled vessels, are gradually, after becoming fully mature, spun or developed into fibrin filaments² of extreme tenuity and transparency, so that by the

¹ The figure at *e*, Pl. I., gives an approximate, though not a strictly correct idea, of a section of an *oval splenic body*. The divergence and convergence of the capillaries are here represented, though not accurately, as they really lie much more compact, with less interstitial tissue than would appear from the figure. They are placed farther apart than they really occur, for the purpose of giving a better idea of their arrangement.

e' represents an arterial extremity or tubular glandule, and *e''* a venal extremity. The capillaries of the *oval splenic body* are made up of the inner layer of fusiform epithelium of the arterial extremity, and connect it with the lining epithelium of a venal branch.

² There has been much scientific experiment and speculation regarding the chemical difference between *albumen* and *fibrin*, and attempts have been made by able chemists to trace by slightly changing the formula, the transition of the for-

time they have reached the veins they enter them as fibrin filaments or as cells far advanced in filamentous metamorphosis.¹ They are now in a condition to move more rapidly, yet they still hug the wall of the vein in the outside stream where they rather creep along than flow.

The capillaries of the oval splenic bodies are so thin and transparent and elastic, and always so filled with cells undergoing metamorphosis, that it is extremely difficult to trace them. When injections are thrown into the spleen the cell products (the so-called splenic pulp) are so adhesive and stick so firmly to the vessels that these thin-walled capillaries are mostly broken down and obliterated.

The fibrin cells, when first set at liberty in the tubular glandules (where they emanate from fusiform epithelial cells possessing the singular property of muscular contractility),² are very large, highly transparent (containing no visible contents), readily yielding to pressure, and appear like globules of highly attenuated matter; though they must have thin walls, as it is impossible to make them coalesce or run into each other by pressure. They soon become more and more opaque, a large central nucleus appears in which granules or minute globules soon become evident. This nucleus soon becomes nucleated, the outside cell wall contracts and finally conforms to the large nucleus, at which juncture we have the mature fibrin cell or colourless corpuscle. The cell now takes on a kneading *amœba*-like movement, and finally filamentous development sets in, and the cell is spun into

mer into the latter, and *vice versa*. The truth appears to be from facts unfolded by these investigations, that there really is no chemical difference. That the sole difference is one of condition merely. That fibrin when reduced to perfect solution is albumen, and possesses no longer the property of forming a fibrinous clot. That when cells are formed from albumen and these are developed into filaments, we have a body which will spontaneously clot, and which is genuine fibrin. That fibrin proper is always in a filamentous condition, and that when it loses this condition, as in the chyme of carnivorous animals that feed largely upon fibrin, it becomes albumen. This will more fully appear further on.

¹ The same or a similar process of fibrin cell spinning is constantly going on in the lacteal and lymphatic glands. Hence the reason why the lacteal fluids clot or coagulate after they have passed through a lacteal gland, which property they did not previously possess. Such cells as escape being developed into filaments in these glands constitute what are called colourless corpuscles of the blood. These exist mostly in the outside stream of the blood, where they move slowly along hugging the wall of the vessel with the fibrin.

² These parent epithelial cells appear to be the parent muscular fibre or fibrin cells, and which possess singular independent powers of contractility. The same class of cells are largely developed in all the lacteal and lymphatic glands; in the arterial extremities (tubular glandules) of the kidneys, where cells are rapidly developed, and in the arterial extremities (tubular glandules) of the liver where cells are also rapidly formed. This subject will be more fully treated of in another paper on the Minute Anatomy, Histology, and Functions of the Lacteal and Lymphatic Glands and of the Liver and Kidneys.

a fibrin filament of extreme tenuity, setting at liberty the nucleus, with some of the surrounding minute pearly globules or cells. All of these changes take place mostly in the thin-walled capillaries of the *oval splenic bodies* (*i*, Pl. I.) during the slow passage through them of the fibrin cells and their filaments. These processes will be described more in detail further on. The *oval splenic body* figured at *i*, Pl. I., is from the human spleen soon after death. The large fibrin cells, in an advanced stage of development, are faintly seen in this body.

These are active organs of the spleen, and are the bodies that have been described as "*splenic cells and pulp*." It is impossible to arrive at their real nature and functions without examining the spleen while the animal is still alive and the spleen engaged in its normal organizing processes; for the reason that the cell products organized in the *tubular glandules* pass so rapidly through their several stages of development and metamorphosis in these bodies, that soon after death the cells in process of formation at death have passed through their several stages of development and metamorphosis and disappeared, while there being no nutrient materials for forming new cells the glandular tubules necessarily become empty or only contain cell products in the last stages of transformation. The *oval splenic bodies* are numerous in the spleen, and constitute the most usual mode by which the arterial extremities communicate with the veins. These bodies are very soft and fragile, being readily broken down between the slides of the microscope, and in minute dissections: on which account the dissections and microscopic manipulations must necessarily be conducted with great patience and caution. Another difficulty exists in the cell products (rapidly undergoing metamorphosis) which distend these bodies and obscure their structure.

At *z*, Pl. I., is represented an epithelial cell from the parent epithelium lining the tubular glandules. The internal layer of this epithelium, when examined *in situ*, seems to consist of oval nuclei which are highly refractive, imbedded in a structureless substance—the walls of the parent cells not being distinguishable in consequence of their extreme paleness. By carefully teasing out this membrane or layer by the aid of fine needles under a magnifier, the cells may be detached when they are recognized as fusiform in shape (*z*, Pl. I.), with a very prominent bulge opposite the situation of their nuclei.

There are two sets of these cells, an internal (*z*) and external (*z'*). The external is generally regarded as purely muscular—known among histologists as non-striated muscle—permanently remaining in an undeveloped condition; while the internal is regarded as epithelium. The internal cells are arranged longitudinally, while the external are arranged transversely. They differ somewhat in appearance, those of the external layer being more finely granular and regularly fusiform. Both possess singular powers of contractility, like that of the muscular fibre. The cells

of the external layer can be more plainly traced than those of the internal. Both of these layers develop fibrin cells.¹ Filaments of highly attenuated fibrin can be seen at 1, Pl. I., penetrating the walls of the oval splenic body and the venal branch emanating therefrom. Beyond where the vein wall is ruptured, is exhibited at *j* the coiled and twisted meshwork of fibrin filaments that make up a great portion of the outside blood stream in the veins that emanate from the oval splenic bodies. After the majority of the fibrin cells are developed into fibrin filaments these filaments with the fibrin cells not metamorphosed pass on into the veins, where they form a hollow cylindrical tunic hugging the inside wall of the veins and arteries, while inside of this cylinder flows a more liquid stream of blood disks and serum. The central current is very rapid in its movement, requiring but a few seconds for it to perform its round of circulation; while the surrounding cylindrical tunic stream of fibrin filaments and cells moves very slowly, apparently creeping along, hugging the inner wall of the bloodvessels. We have then in the bloodvessels of all parts of the body *two blood streams*, an outside and a central. The outside stream moves slowly and contains the fibrin filaments and cells and other nutrient products for nourishing the tissues, while the inside stream contains but few fibrin filaments and fibrin cells (colourless corpuscles), and moves with rapidity.

When a part is irritated and becomes inflamed, or when there is any lesion resulting in inflammation, there is a tendency for the outside current or nutrient cylinder of fibrin filaments and cells to become thicker and thicker, in proportion to the height of the inflammation, and the central current to become smaller and smaller till the former fills the entire blood-vessel, and the central current is entirely excluded, when there results a fibrin clot choking up the vessel; which condition is often followed by gangrene and sloughing. The central current appears to be essential to the progress in movement of the outside stream.

Arteries terminate in Malpighian Bodies.—This is, strictly speaking, rather an unusual mode of arterial termination in the spleen. Yet it is sometimes met with, and more frequently in birds than in any other animals I have examined. At *h*, Pl. I., is seen a representation of a sample

¹ We call the attention of histologists particularly to these layers of fusiform cells lining the tubular glandules. They exist to some extent throughout the arteries, but nowhere assume the development that they do in the arterial extremities of the glands, and especially of the spleen and lacteal and lymphatic glands. They are highly interesting elements in the process of cell organization. The external layer is known as non-striated muscle, permanently remaining in an undeveloped condition. The fibrin cells developed from the fusiform cells in their passage through the spleen, assume during one stage in their filamentous transformation a strong resemblance to their fusiform parent cell.

of this mode of arterial termination. The outside wall of the tubular glandule (arterial extremity) expands, forming a delicate outer coat of connecting tissue for the Malpighian corpuscle, while the inner tunic of the artery as it enters the Malpighian body, continues to send off diverging capillary branches on every side like the radiating branches of a tree, while the main central trunk of the internal tunic passes directly through the centre. The fibrin cells developed in the tubular glandules hugging the wall of the central vessels, pass into the diverging capillaries as they come up with their mouths; while the red globules and serum maintain for the most part the central channel.

There appears, however, to be no direct communication between the Malpighian tissue and the bloodvessels, save through the thin capillary walls.

The walls of the capillary vessels appear to be made up entirely of the inside layer of fusiform epithelium lining the arteries. These cells are arranged longitudinally, the same as in the arterial extremities, and each is provided with a nucleus which is plainly visible in the capillary wall. The boundaries of these cells are, however, quite indistinct under the best glasses, so closely are their edges blended and united to each other. By carefully teasing out a capillary vessel with fine needles under a magnifier, occasionally one of these fusiform cells with its contained nucleus may be separated. The epithelial cells possess the peculiar property of transmitting minute bodies under particular states and circumstances. This power of transmission is much greater than is generally supposed. Filamentous fibrin, and even blood disks and the spores of cryptogams, under the proper conditions, freely pass. In acute catarrh, or when the system is under the influence of large doses of iodide of potassium, blood disks without any hematin pass through the capillary walls in large numbers, and flow from the mucous nasal surfaces in the white clear watery serum. This any one with a fair microscope can test for himself.

The spores of cryptogams are found largely throughout the tissues, often, and in the blood and frequently in great abundance in the urine. These spores and blood disks are much greater in diameter than the highly attenuated and transparent filaments of fibrin in the blood.

Amyloid Glandules.—In the spleen are found minute bodies containing a mesh of highly refractive pearly cylindrical capillaries (*f*, Pl. I.). These capillary vessels are readily broken across, fracturing apparently like glass. They are always distended, highly refractive, and of a beautifully pearly lustre. They resemble a meshwork of fine pearl glass tubules. In these vessels may be noticed minute pearly drops, and on the membrane stretched across the meshes, the same kind of pearly drops aggregate into more or less spherical masses (*f'*), and finally these spherical masses of globules appear to melt down and gradually form one or more large globules (*f''*).

These large globules subsequently take on a cell wall, and we have formed the genuine corpora amylacea. The cell walls soon begin to fracture around the edges and in the centre, and allow a peculiar refractive highly plastic fluid to escape. After the contents have escaped the cell cases keep on fracturing and finally entirely break up and disappear. They are found in all stages of disintegration in the blood stream. At *g*, Pl. I., is represented a side view of an emptied so-called amyloid cell, and at *g'* an edge view, showing that they are flattened circular cells. They are often marked by concentric rings.

These cells are not amyloid in their character, as has been supposed. They are the true *myaline* cells, or those cells which contain medullary nerve matter. The contents of these cells, after it has escaped from the cases, become aggregated into large globular masses (*k*, Pl. I.), and from the sides of which are developed beautiful, double-walled, pearly, tubular filaments, precisely like those of nerve tissue. These filaments extend and contract over and over again, double up, become beaded, and finally break up into beautiful globules as seen at *m*, and *m'*, Pl. I., which is in every respect analogous to the medullary nerve matter of the brain and spinal cord.

In health, this amyloid matter forms a thin plastic covering to the blood disk, which becomes its vehicle of transmission, which to a certain extent insulates it, and renders it plastic, pearly, and yielding. The amount of this substance investing the blood disks is in direct proportion to the causes exhausting nerve tissue. Its amount present and attached to or in the blood disks, is readily indicated by their plasticity, the readiness with which they yield to every external force, their tendency to stick together, so that, as they separate, filamentous prolongations are drawn out from each, and their little liability to arrange themselves in piles or to become nummulated, and by their pale red pearly hue. The absence of this medullary matter is indicated by the deep red opaque colour of the disks, their rigid nummulated form, the tendency to arrange themselves in piles and want of pliability and plasticity.

By this means those labouring under exhausting nerve influences, such as excessive mental labour, nervous excitement, or exhausting disease, may be readily distinguished from those strong, robust, merely physical persons who trouble themselves little in a mental way about anything.

This interesting and beautiful application of a truth, affords the medical practitioner a simple and valuable diagnostic aid in disease, and points out to us again where the microscope may be of important service to the physician.

In the spleen are developed so-called corpora amylacea. We can no longer hold to the idea of these bodies being at all allied either to starch or cellulose. They are strictly speaking *myaline cells*, and are filled with

medullary nerve matter¹ and contribute to make up what has been denominated globulin of the blood disk.

Virchow discovered that the so-called corpora amylacea (myaline cells), occurred largely in nerve tissue. He found that they existed to the greatest extent and in the greatest numbers in the ependyma of the ventricles and spinal canal, and that they are more abundant the greater the thickness of the ependyma. Whenever from any pathological cause the neuroglia becomes increased, the so-called corpora amylacea (myaline cells) are correspondingly multiplied.

Here we see that Virchow found these bodies intimately connected with nerve tissue.

It is now about thirteen years since Virchow first discovered the peculiar reaction of the corpora amylacea (myaline cells) found in the nervous centres with iodine. These bodies, from this peculiar reaction (iodine striking with these cells a beautiful blue and sometimes a green if albumen is present), have by some been regarded as real starch, and by others analogous to cellulose. Virchow next discovered these cells in a diseased spleen (sagoey spleen) and subsequently they have been found in diseased kidneys and livers, and in diseased tissues.

Virchow regards these amyloid bodies (myaline cells) as more analogous to cellulose than to starch. But from cellulose again they are distinguished by the fact of their becoming coloured blue on the application of a pure solution of *iodine alone*. *Cellulose* behaves precisely like *cholesterine*, which remains colourless when treated with iodine, but on the other hand assumes a blue, or under certain circumstances a red or orange colour upon the addition of iodine and sulphuric acid. Virchow says that amyloid bodies are believed not to occur in the blood. The reverse of this, however, is true. They are very frequently met with in the blood of many persons that I have examined. As they appear in the blood, they are

¹ The matter in the myaline cell (so-called corpora amylacea) which causes them to assume a *blue colour with iodine*, resides wholly in the cell membrane or case. This peculiar substance has given rise to the general opinion that these bodies are amyloid or starchy in their nature. This body is soluble in ether, and crystallizes from the ethereal solution, in beautiful acicular crystals that arrange themselves in a stellate manner, or radiate from a central point.

It resembles seroline somewhat, only the crystals are not as long and slender. It probably is one of the unsaponifiable fats resembling cholesterin and serolin. It is coloured a beautiful blue (ultramarine) with iodine. On account of the peculiar similarity between this body and starch in its deportment with iodine, and out of deference to the term given to the bodies by Virchow, from which it is obtained, I propose for it the name of *Neuro Amyline*.

It has led histologists and physiologists to adopt very erroneous views regarding the character of the so-called *corpora amylacea*, and shows upon what slight grounds grave errors may be made in histological and physiological inquiries.

generally emptied of their contents, merely exhibiting thin, flattened, concentric, usually fractured, highly refractive cases.

These amyloid bodies (myaline cells) are the same as are developed in the spleen. They are the true myaline cells filled with medullary nerve matter. This medullary matter is discharged from the cell cases, which, when they have become emptied of their contents, become fractured in various ways in the centre, and around the edges; and within, appear concentric markings. Their contents is a highly refractive, pearly, viscid matter in the form of globules. Soon after its discharge it begins to change its shape, moving slowly, and finally sends out numerous tubular filaments in various directions, which extend and contract and extend, creeping about in various ways, subsequently breaking up into beautiful globules which appear to be single or double rings (*m*, *x*, and *m'*, Pl. I.). These are taken up by the blood disks which transmit them to their destinations. This matter communicates a high degree of plasticity, and refractive pearly lustre to the disks. This appearance is in direct proportion to the activity of the nervous system. So strongly marked is this, that by simply examining the blood microscopically, it can readily be determined whether a person is actively engaged in mental pursuits, under the influence of nervous exhaustion of any kind, or whether he is purely devoted to physical undertakings, is strong and robust, and is labouring under no influence which is exhausting his nerve tissue.

The contents of these myaline cells perform an important office in communicating plasticity to the walls of the fibrin cells and filaments. Little drops of it are often seen attached to the fibrin filaments after they have become developed from the fibrin cells. These become aggregated and are subsequently developed into filaments, and finally these filaments break up into globules as before described.

The medullary nerve matter, or myaline from the myaline cells, performs the office of surrounding the axis cylinder of the nerves, forming an insulating tunic between it and the nerve sheath, which prevents the nerve force from escaping in its transit save at the terminus. In low typhoid types of disease, this medullary matter is seen in little pearly rings or globules, and in beautiful beaded tubuli often in the blood.

From such experiments as I have made, I am satisfied that cholesterin is found in these cells, and is a constituent of medullary nerve matter. This matter makes up the little pearly globules in mammillated blood disks, or in the blood disks of blood deprived to a greater or less extent of its normal fluid.¹

Fibrin Cells and Filaments.—In birds, reptiles, and fishes, if the spleen

¹ This condition arises in all states of the system where the fluids of the body are being rapidly appropriated, or carried off, as in nursing females, tobacco chewers, exhausting diarrhœa, in diabetes, in chronic diuresis, and in cases where there is extensive ulceration.

be examined carefully, while the animals are still alive, under a microscope of sufficient power, by one familiar with minute dissections and nice microscopic manipulations, there will be observed plastic, highly transparent cells, which are produced in large numbers in the *tubular glandules*, from the parent fusiform cells of the lining epithelium. These cells at first have no visible contents.¹

They soon, however, present evidence of having cell walls of considerable firmness, and a large central nucleus becomes faintly visible. Subsequently this nucleus becomes nucleated. The cells gradually become more and more adhesive and plastic, sticking to each other in masses as they enter the diverging capillaries of the oval splenic bodies, clogging them up, so that the cells are retarded in their forward movement.

This clogging up of the vessels causes an expansion of these bodies and a consequent enlargement of the spleen.

At this stage, there is a transparent space between the outside cell wall and that of the nucleated nucleus, which space is free from any perceptible contents. The outside cell wall, which is of extreme tenuity, gradually contracts, so as to soon conform perfectly to the cell wall of the nucleus, thus giving the nucleus a double envelope, and which now becomes the cell, while the former nucleolus becomes the nucleus. At this stage in its development, the cell constitutes what is known as the colourless corpuscle of the blood, but really is a mature *fibrin cell*. Now begins a peculiar filamentous metamorphosis of the *fibrin cell*, by which it is developed into a filament of extreme tenuity and transparency.

As the filaments are developed, the cells slowly progress, and by the time they have reached the venal branches they are either fully developed into filaments or are far advanced in this direction.

Here they meet the central blood current, of blood disks and serum, around which they form, with the undeveloped fibrin cells, a cylindrical tunic, which hugs the walls of the vessels along which they rather creep than flow. During rapid digestion, and immediately following it, the oval splenic bodies become greatly distended with developing cells and the spleen much enlarged. This distension is relieved in about four hours after feeding.

¹ Cells in their early stage of formation in the spleen take on a kind of independent motion, analogous to that exhibited in low protozoon animal organisms, belonging to the so-called *genus Amœba*. Their movements and changes in form belong to the same set of actions; the changeable mass puts forth one or more finger-like prolongations into which the whole body is carried, causing it to change its place. This is immediately followed by prolongations in other directions which in turn expand and receive the entire organism. By this peculiar kneading motion the organisms progress. From this remarkable similarity it would appear, that perhaps forms of the so-called *genus Amœba* may represent but early stages in the organizations of certain epithelial cell products of animals of a higher type of organization.

The central nucleus of the *fibrin cell* does not become incorporated with the fibrin filament, but is set at liberty with some of the minute pearly globules surrounding it. Others of the pearly globules, or rather minute cells, pass into the tubular fibrin filament during its process of elongation, where they are arranged in single file along the central cavity, forming that peculiar interrupted central structure of an ultimate muscular filament.

The fibrin cells, during their filamentous development, become coated with plastic matter from the *myaline cells*. After the filaments are fully developed, this matter becomes more or less aggregated in little pearly drops along the threads, subsequently (removed from the body) collect together, and are developed into tubular medullary matter (*k* and *l*, Pl. I.). In the live animal, it is no doubt transmitted to its destination before it undergoes filamentous development, or goes to nourish nerve tissue. The blood disks of birds, reptiles, and fishes are peculiar in having a nucleated nucleus. This nucleated nucleus is really a fibrin cell, being, after its escape, one kind of colourless corpuscle of the blood. These fibrin cells, like the fibrin cells of mammals, undergo a filamentous development. This process is beautifully exhibited in the spleen of the turkey and common fowl. As soon as the central nucleus is expelled, the blood disks appear shrunken. They soon, however, absorb more liquid products and hematin, and become again plump and full.

In mammals the mode of formation is essentially the same, but slightly different in some of its details. On account of mammals being less tenacious of life, the examinations cannot be so successfully conducted on the spleen while its normal functions are in progress, as they can on the spleen of the reptilia. With care, however, the cells can be traced through quite all the stages of their formation and metamorphosis. Here we have briefly stated the simple and highly interesting process by which fibrin cells and filaments are formed from the albuminous matters of the blood.

In studying the embryology and successive transformations of the cells of the spleen, those animals the most tenacious of life furnish the best subjects.

The turtle is a good example. The breast-plate can be removed, the animal secured on its back, the spleen exposed, and microscopic examinations continued for hours on this organ while its normal functions are going on.

The successive changes of the cell products of the spleen are so rapid that, in a very short time after death, all of the earlier cell transformations are passed through with, so that nothing is visible save the latter stages in the process and the resultant cell products. On this account, it is impossible to study the early cell morphological processes in the human spleen. If the spleen, however, is examined very soon after death, all of the later cell changes are exhibited.

Birds, fishes, and reptiles, all furnish good subjects for splenic study, and among mammals, dogs, cats, the raccoon, pig, opossum, ox, horse, and sheep are all good examples.

In several instances, I have been able to trace through all their stages the gradual melting down of connective tissue filaments into a plastic, transparent pabulum, and the subsequent formation from this pabulum of first, minute, highly transparent cells (which probably existed in embryo in the filamentous tube) which soon became granular, and, after several hours, had the appearance of highly transparent pus cells. The whole time required for this process was from twelve to eighteen hours. The changes were all gone through with between the slides under the microscope.

Whether this may represent one mode in which pus cells are formed from connective tissue, I am at this stage of the inquiry unable to say. Still, it is quite probable that it may be, and that it is a mode in which filamentous tissues are disintegrated and carried out of the system. In the pabular state they could readily be eliminated.

At Pl. I., *y*, is seen the early appearance of a *fibrin cell* while it is yet in the tubular glandule. At *n* is represented the mature fibrin cell. At *o* it begins to take on the filamentous development, and has projecting posteriorly a fine hair-like process. At *p* is seen a still later stage, when the filament has become enlarged and elongated, and is now discovered to be tubular. At *g* its tubular appearance is more marked, the minute cell contents of the fibrin cell having quite all passed into the filament. At *r* the nucleus is about being liberated, and the filament nearly perfect in its development. At *s* the filament is seen separated from the nucleus, and is perfectly developed. At *t* and *u* are exhibited other forms of the filamentous development of fibrin cells.

Albumen and Fibrin Cells and Filaments.—The albumen of nutrient materials is converted into fibrin in the spleen and lacteal and lymphatic glands by first being organized into fibrin cells. These cells, after undergoing certain changes in character and appearance, are transformed into filaments of fibrin, as previously described.¹ The cells organized from albuminous materials, and which are known as colourless corpuscles of the blood, are here denominated *fibrin cells*, as this name indicates more precisely their real character.

There have been much scientific experiment and speculation regarding the

¹ Mucous cells also undergo filamentous development, and to the highly transparent and loose structured filaments formed from the mucous cells, is the ropy properties of this substance mainly due.

A too rapid and hasty development of these cells in certain diseased states of the body may result in serious pathological states, as in the exudations in angina maligna, in common diphtheria and in scarlatina. The mucous cells in these diseases become fibrinous.

chemical difference between *albumen* and *fibrin*, and attempts have been made by able chemists to trace, by slightly changing the formula, the transition of the former into the latter, and *vice versa*. The truth appears to be, from facts unfolded in these investigations, that there really is no chemical difference. That the sole difference is one of condition merely. That *fibrin*, when reduced to perfect *solution*, is *albumen*, and possesses no longer the property of forming a fibrinous clot. That when cells are formed from albumen and these are developed into filaments, we have a body which will spontaneously clot, and which is genuine fibrin. That *fibrin* proper is always either in a cellular or filamentous condition, and that when it loses these states by being dissolved, as in the chyme and chyle of carnivorous animals who feed largely upon fibrin, it becomes albumen.

Blood Disks.—The blood disk is a cell proper, with a cell wall, as is made evident by dissolving its hematin and other contents from it, and from the further fact that the blood disks of birds, reptiles, and fishes have a well-defined nucleolated cell nucleus, which subsequently escapes from the disks.

There is still further evidence that blood disks have a cell wall. If the blood disks of birds, reptiles, and fishes be placed in water, it will be found after a little time that the hematin and other products have been dissolved out, save from the nucleus, and the outside cell wall will be found folded and wrinkled, and the nucleus will appear very plain, while the outside cell wall presents itself as a highly transparent, more or less folded and wrinkled disk of extreme tenuity. Further, if the blood disks of mammals be placed in water, it will be found after a time that the cell products have become all dissolved out, leaving the thin membranous walls folded and twisted in various ways, and many of them so collapsed that they appear as mere short irregular beaded lines. Many of them have the appearance of the wrinkled and folded nuclei of the colourless corpuscles which are found abundantly in the spleen, lacteal and lymphatic glands, and thoracic duct.

These statements are made for the reason that some recent physiologists regard the blood disks as homogeneous throughout, they having no cell wall.

In mammals blood disks are formed from the nuclei of fibrin cells. When the fibrin cells are developed into filaments their nuclei are set at liberty, take up nerve and colouring matters, become highly transparent and homogeneous, assume a flattened shape, and form blood disks. This process can be traced through all its stages in the living spleen.

In birds, fishes, and reptiles one form of the fibrin cell makes up the nucleus of the blood disk from which it escapes and is subsequently developed into a fibrin filament. The spleen, and lacteal and lymphatic glands, are the main organs that organize fibrin cells and blood disks.

Of all these glands the spleen is the most important, and the most largely engaged in this cell forming process.

Bodies Resembling Confervoid Filaments.—At Pl. I., v, is represented a peculiar kind of filament which occurs abundantly in the spleen. These filaments possess a slight degree of independent motion, which is oscillatory, or a slow, irregular, intermittent, backward and forward motion of the extremities. They are the mature state of the so-called vibriones (*w*). They occur abundantly in the human spleen and in the spleen of all animals, so that their presence is not abnormal.

Their universal presence is indicative that they perform some important function in the animal organic processes. Similar filaments (apparently different species) occur in all the other glands of the body. The glands seem to be the principal habitat of the mature state of these singular bodies. After the death of the animal they are developed in incalculable numbers during the incipient stage of decomposition, and often in the excretions in low types of disease. Their presence in large numbers is indicative of low states of vitality, where rapid interstitial death and decay are in progress, or of the entire absence of vitality and the inauguration of fermentating and decomposing changes. They appear to act especially as a ferment accelerating fermentation and decay, in both animal and vegetable tissues. They are always present in all animals, and only await either low conditions of vitality or its cessation to multiply in vast numbers. By their presence in animal tissues, they are believed to perform an important function in exciting such interstitial changes in effete particles as to reduce dead and useless matter to those states in which it may be readily eliminated. If this should prove as true as at this stage of the inquiry it appears to be, these interesting little bodies are not without their important use in the animal and vegetable economy. In health they are very much less active than in disease, their movements being scarcely perceptible.

These organisms appear to be confervoid in character and mode of development. There is evidence of their being many distinct species, even in the same animal, as they differ somewhat in appearance in the different glands. Those of the same gland in different individuals appear to be, however, quite similar. In structure and movements they resemble the *Oscillaria*. They excite fermentative changes both in animal and vegetable matters. In their early stages of development they are extremely minute and short. They grow by extending in length, and in their early condition appear more plainly jointed than at more advanced stages. These interesting organisms will be treated of more fully in a paper now ready for the press on Fermentation, Gangrene, Decay, &c.

Cholesterin and Serolin and Neuro-Amyline.—In chemical examinations of the spleen this organ has been found¹ to form largely cholesterin

¹ The paper containing the experiments on this subject is not yet published. These experiments decide the point that cholesterin and serolin are developed

and serolin in its organizing processes. Also a beautiful crystalline matter soluble in ether, and probably another unsaponifiable fat, coloured intensely blue with iodine, is formed in the cell cases of the myaline cells. This body we have given the name of *neuro-myaline* for reasons previously stated, in describing the myaline cells and their contents.

Experiments connected with the lacteal and lymphatic glands prove them also to be other sources of the unsaponifiable fats cholesterin and serolin. A careful examination of the substance of the liver has determined the fact that cholesterin and serolin are not formed in the cells of this organ, but simply secreted by the biliary apparatus (the interlobular cells in their organizing processes) from the portal blood coming from the spleen and lacteal system.

These conclusions are the results of experiments as follows: A portion of the spleen was taken immediately after the death of the animal and treated with ether till no more cholesterin and serolin could be obtained. It was then set aside for twenty-four hours, when on again treating the same portion of the spleen with ether an additional quantity of these bodies was obtained, and this gradual formation of these bodies continued till the transformations in the cell products ceased. The lymphatic and lacteal glands were subjected to similar examinations with similar results. On, however, subjecting the liver to this process a very small quantity of cholesterin and serolin was obtained. On re-treating this same portion of the liver with ether twenty-four, forty-eight, and seventy-two hours after, although cell changes had been going on in the liver as they had under similar circumstances in the spleen and lacteal and lymphatic glands, no trace of these bodies could be separated.

These experiments afford proof that the spleen and lacteal and lymphatic glands are true sources of cholesterin and serolin, while the liver is not; the biliary apparatus of this organ merely secreting these bodies from the portal blood.

Fermentation in the Spleen.—When the spleen of the common fowl is set aside, exposed to conditions which induce decay, in connection with the decay which takes place, alcoholic fermentation sets in, which develops *torula cells and filaments* in considerable quantities, producing in a short time a white mould or dust of cells and filaments over the whole surface.

These torula cells are smaller than those developed in fermenting liver, but of the same general character.

These cells are like those which I have frequently met with in the blood of patients labouring under fevers.

The development of these cells in the decaying spleen is an indication of in the spleen during its organic processes. That cholesterin and neuro-amylane are found in the myaline cells so called (*corpora amylacea*), the former in the cells and the latter in the cell membranes.

the presence of glycogenic matter or sugar in some form, and which is probably generated by it.

Filamentous Fibrin in the Blood.—The presence of filamentous fibrin in the living blood is rendered evident from the fact that these filaments are formed from fibrin cells, by a regular process of filamentous development, which is constantly going on in the spleen and the lacteal and lymphatic glands. It may be detected in the blood, previous to the process of clotting, as follows:—

Receive a drop of blood as it flows upon a warm (100° F.) glass slide, place thin glass over it, and immediately introduce it under the microscope, with the focus previously arranged, so that the eye rests upon it in less than two seconds after it leaves the bloodvessels.

Three sets of cells and blood disks will at once be noticed. One moves freely in any direction with the current. Another set occurs in little masses and lines, and are more or less stationary, turning the freely movable cells out of their course; while the third are twitching and moving or oscillating backward and forward as if tied together by elastic filaments. The apparently stationary masses and lines of cells and disks, and those oscillating or approaching and receding from each other as if connected by elastic threads, will be found on close examination to be controlled in their motions by fine and highly transparent filaments of fibrin, that are precisely like those that are developed from fibrin cells. Another mode for detecting their presence, previous to the process of clotting, is to prepare a weak alkaline solution, make an incision and receive a fresh drop of blood as it flows upon a warm glass slide with a drop of warm alkaline solution, cover with thin glass, and then press upon the thin glass with a clean folded cloth, which presses out from between the slides the movable disks and most of the alkaline solution, which are absorbed by the cloth. Place under the adjusted microscope, where the eye can rest upon it in less than three seconds after it leaves the blood stream. The fine meshwork of fibrin filaments can now be seen and studied nearly as they exist in the living bloodvessels. They will be seen arranged in a web or meshwork, or in small bundles. Along the course of the filaments are attached the minute granules or cells of the fibrin cells (colourless corpuscles), and attached to the filaments will also be found colourless corpuscles, and many partially disintegrated cells and blood disks.¹

¹ I am aware that Virchow, and many other investigators of the present day, not having succeeded in tracing satisfactorily the true source of the fibrin of the blood, are leaning towards the opinion that it originates from the fibrinous tissues—is matter in the process of disintegration—is taken up by the lymphatics and transferred to the blood stream, and is to be excreted from the body by the different glands. Bennett, in his work on Clinical Medicine, says: "The effete matters absorbed into the blood circulate with it, and always form an important part of its

This brief statement will be sufficient to guide the inquirer, while he can greatly vary his observations according as his ingenuity may suggest. The more thorough and varied his examinations, the more convincing will be the evidence. The evidence will be made still more satisfactory by carefully tracing the *fibrin cell* from its early stages of development through all its metamorphoses till it finally becomes a filament of fibrin.

The following remarks of Virchow are interesting in this connection:—

“The fibrils of connective tissue only differ from the fibrin of the blood in not being reticulated, but run a parallel course, whilst in other respects they resemble those of fibrin in a high degree. The intercellular substance of connective tissue presents another point of resemblance with fibrin in the great analogy of its behaviour with reagents. When we expose it to the action of dilute acids, the fibres swell up and disappear before our eyes, so that we are no longer able to say where they are. The mass swells up, every interspace disappears, and it looks as if the whole were composed of a perfectly homogeneous substance. If we slowly wash it, and remove again the acid, a fibrous tissue may—if the action of the acid has not been too violent—once more be obtained; after which the previous condition can be produced afresh and changed again at pleasure. This behaviour has hitherto remained unexplained, and for this very reason Reichert’s view—that the substance of connective tissue is really homogeneous, and the fibres are only an artificial product or an optical delusion—has something alluring in it. In fibrin, however, the individual fibres can much more distinctly, than is the case with connective tissue, be so completely isolated, that I cannot help saying that I regard the separation into single fibres as really taking place, and not merely as an artificial one, or as a delusion on the part of the observer.”

These remarks and quotations of Virchow are highly interesting in this connection, showing that under the influence of dilute acids the fibrillæ of of the muscular and connective tissues, and of the coagulum of the blood, may be rendered invisible to the eye of the observer, and on carefully removing the acid, the fibrillæ again become visible. Reichert’s view of the matter, viz., that these fibrillæ are really an optical delusion, and that the material is really homogeneous, has, as Virchow says, something alluring about it, from the fact that it is wholly imaginary. Fresh blood, or the blood in the vessels of the living body, and immediately after it is drawn, has its fibrin in a similar invisible condition, as are the fibrillæ of blood to which dilute acid has been added. This is a point highly interesting, and one presenting strong evidence in favour of the statements and observations set forth in this paper, viz., that the fibrillæ of the fibrin of the blood are developed from cells, and exist as fibrillæ in the living blood, and that coagulation is merely the contraction and aggregation of those fibrillæ, and the rendering of them visible.

Virchow further says:—

“But it is very interesting to observe that the fibrillar stage of fibrin is invariably preceded by a homogeneous one, just as connective tissue originally composition. It was first maintained by Zimmerman that they constitute the *fibrin of the blood*, which instead of being exuded to form the tissues, as has been generally supposed, is excreted from the body by the different glands.”

wears the form of a homogeneous intercellular substance (mucus), from which fibres are only by degrees, if I may so express myself, excreted, or, to employ the usual term, differentiated."

Instead of being differentiated from a homogeneous mucous substance, they are developed from cells in the same way that the fibrin of the blood is developed. See (1) Plate I. Virchow says further: "So fibrin too, which is first of all gelatinous, becomes differentiated into a fibrillar mass."

It is singular that at this age after so much has been done in the embryology of animals, and in that of the various organic elements which compose them, that the views with regard to the development of the various fibrillar tissues of the body should be so at variance with those of other organic elements, and with the development of animal organisms. That fibres should spring "full fledged" from the amorphous fluid mass, is an anomaly in organic development.

Finally, the same author draws the following comparison between the formation of these organic elements and crystallization from inorganic solutions, thus: "And indeed in the case of inorganic substances also, we find certain analogous appearances. From deposits of calcareous salts, or silicic acid, which were originally perfectly gelatinous and amorphous, solid granules and crystals are gradually separated."

Here we have by the ablest of histologists a comparison drawn (after being, no doubt, much puzzled at the peculiar apparent mode of development of the fibrillæ of fibrous tissue) between the formation of organic fibrillæ and the development of crystals and granules, in gelatinuous solutions of calcareous and silicic acid salts. No one would be willing, however, to admit that the formation of organic fibrillæ bears any analogy, in fact, to that of inorganic crystallizations.

At Plate I., *a, a, a*, are represented parent connective tissue cells, and at *b, b, c, c, c*, and *d*, same plate, the nuclei of these cells are seen in all stages of filamentous metamorphosis. The connective tissue cell is developed in connective tissue, which is, in one sense, an extravascular tissue like the epithelial. These cells are unlike any other cells in the animal organism. They have very thin, homogeneous walls, and are usually oval, containing one or more plain homogeneous oval nuclei which are the true connective fibre cells, or the cells which are developed into filaments. These nuclei escape from the parent cells, and undergo the filamentous metamorphosis. These homogeneous cells make homogeneous filaments. It is believed at this stage of the inquiry that the parent cells themselves make elastic fibrous tissue, while the nuclei make the non-elastic.

Clotting of Blood.—The clotting of blood, consists in the gradual contraction and aggregation of the fine fibrin filaments existing in the blood. The peculiar backward and forward motion, or the oscillatory movement of the blood disks, between the slides of the microscope, are produced by this clotting process.

Tendency of the Blood to Coagulate in the Vessels of the Living Body in Disease, and Means of controlling such Tendency.—In many pathological conditions of the system there is a strong tendency in the fibrinous filaments of the blood to contract, aggregate and form in the vessels what we usually call clot. From the simple process before described this tendency of the blood to coagulate in the living system can quite readily be determined, and, after careful practice by the physician, may be used by him as a valuable diagnostic aid. The condition of the blood will indicate, to some extent, the therapeutical management of the case. There appears to be a coagulating tendency of the blood in all inflammatory types of disease, and also in many low typhoid conditions of the system. Wherever this tendency exists, there is a *lax condition* of the muscular fibres, especially those of organic life. This disposition of the fibrin to coagulate, and the lax condition of the muscular fibres, constitute often grave parts of disease, and should be combated with such appropriate remedies as will operate against and counteract these tendencies, or gangrene may result. The alkalies and their vegetable acid salts are known to retard the coagulation of the blood and to thin it by increasing cell elimination. Veratria has a remarkable influence in preserving the arterial condition, and in preventing the coagulation of the blood. (See paper on poisoning with the vegetable alkaloids, published in the Oct. No. of the *American Journal of the Medical Sciences*, 1862.) My experience with this body, however, extends only to its effects in poisonous doses, and to its influence upon blood out of the body. Its effects are, however, so marked that I feel an interest in calling attention to its trial in smaller and more diluted doses than is usually given for combating tendencies to the coagulation of the blood in disease.

I know of no body, in the whole range of our materia medica, so admirably adapted for restoring the normal tonic tone of the muscular fibres, as aconite. It acts speedily and effectually, in giving a strong tonic contractile power to all the muscular fibres of the animal body, and especially to those of organic life. The tonic condition produced by this body is persistent and continuous. It is not intermittent like that of strychnia, picrotoxin, veratria, &c.

Homœopathists use this body in all inflammatory diseases, but without understanding that its beneficial influence in these abnormal conditions arises from its action upon the muscular fibres. The tincture prepared according to the U. S. Dispensary, is a convenient form in which to administer this body. No tincture should be used, unless when on applying a drop to the tongue, it produces a numb, tonic, astringent sensation, in from three to eight minutes after being applied. This sensation should last from two to six hours.

For an adult, about five to six drops of such tincture should be placed in a tumbler of pure water, well stirred, and a tablespoonful given every

twenty minutes, till eight to twelve drops are given. This will be about as much as should be administered in twenty-four hours to a grown person of ordinary strength.

This treatment should not interfere with that ordinarily followed. It is resorted to as an aid, merely, in restoring the muscular fibres to their normal tonic tone, and in preserving the fluidity of the blood, till other appropriate therapeutical means may produce that alterative action required to restore the system to its normal condition.

Iron and quinia are two of our most valuable remedies, in checking the too rapid development of fibrin cells, and their too rapid metamorphosis into filaments. These bodies should be given in liberal doses, often repeated and continued till the blood presents under the microscope a healthy appearance.

Spleen Small in Fœtus and tends to Decrease in Size in Old Age.—It has been observed that the spleen is particularly small in the fœtus, till near the time of pregnancy, when it increases rapidly in size. The functions of this organ, as previously described, explains the reason. The fœtus derives its nourishment from the products organized by the mother, and hence requires of itself no organs for this purpose, till it becomes an independent being. As the period of foetal maturity approaches, the spleen becomes rapidly enlarged, in order to be fitted as soon as the fœtus is discharged, to organize products for its tissues. In old age, the spleen has been noticed to diminish in size.

This is what we might expect from the fact that the powers of life become feeble in advanced years, and the system requires much less of organized products to sustain it. The spleen hence, having less to do, gradually diminishes in size.

From the Third to the Fifth Hour after Feeding, the Spleen is Increased in Size.—Soon after feeding, and during and following active digestion, cells are organized in the spleen rapidly. During the development and transformation of these cells into filaments, in the tubular glandules, and oval splenic bodies, they distend the vessels of the latter, on which account the spleen is augmented in bulk. As soon as, or soon after rapid digestion is over, cells are organized less rapidly, and the oval splenic bodies are relieved in a measure, in consequence of which the whole organ contracts to its normal bulk. This explains the interesting fact noticed by Sir E. Home, that soon after a meal the spleen becomes enlarged, in which condition it remains for a short time, and then returns again to its normal size.

Large Size of the Bloodvessels of the Spleen.—The important functions of the spleen are explanatory of the very large size of the bloodvessels of this organ. They explain still further why it is, that it is necessary for the splenic vein to be so much larger than the splenic artery. The spleen is essentially an organ engaged in organizing blood products

for replenishing the constant waste in the blood stream, in consequence of which it requires blood not only for its own nourishment, but also nutrient products, from which it may assimilate and organize products for the replenishing of the blood and the support of the fibrinous tissues.

This extra demand requires enlarged means to conduct the desired materials. Much of the blood which enters the splenic artery is in a liquid form ; much of the fluid albumen in this liquid becomes organized into fibrin cells in the tubular glandules. These cells are developed into filaments, and these, with the cell products undeveloped, are less readily transmitted through the veins than the liquid products through the arteries. On this account the splenic vein is increased in size above that of the splenic artery, so that these bulky products may be without difficulty transmitted.

Animals deprived of the Spleen have a Ravenous Appetite, and tend to fatten.—The interesting fact has for some time been known that when animals are deprived of the spleen their appetite becomes peculiarly ravenous, they eating much more abundantly than before they were deprived of this organ, and are not as particular about what they eat. The functions of the spleen explain why this is so. The animals being deprived of one of the great and important organs which organize fibrinous materials and blood disks, the other organs (lacteal and lymphatic glands) which perform similar offices, are unable to supply the system with enough fibrinous materials from the same amount of food, as this food is digested in the same time without a spleen as it is with one. To keep up the supply of fibrinous products, it becomes necessary for the lacteal and lymphatic glands to work more of the time. That beautiful sympathy of action which exists between the wants of the tissues and the organs which supply them with organized nourishment, produces an increased appetite, resulting in more often and thoroughly filling the stomach, so that digestion may continue a greater proportion of the time than is ordinarily required. This enables the lacteal and lymphatic glands, by somewhat overtaxed efforts, to keep up the supply of organized products. The lymphatics become so stimulated to extra exertions that they are gradually increased in size, so as the better to enable them to perform their own normal functions together with those of an absent spleen.

It has also been noticed that animals fatten more rapidly and readily after the removal of the spleen than before. The reason of this is obvious. The organs that produce the majority of the fatty products for the system are not removed, they still being engaged in their normal functions. More nutrient products passing through them than under normal conditions, and these passing more continuously, enable the fat forming glands to organize more fat than usual, to be appropriated. The result is an increased disposition to the formation and deposition of adipose.

Concluding Remarks.—In conclusion, we wish to present some physio-

logical and pathological phenomena, noticed by others, relating to this organ and its diseases, and which are important and interesting in this connection, in the way of corroborating the results which we have arrived at in the study of this gland. On the contrary, our labours will be seen to explain and render clear the observations of others. This remarkable coincidence of reciprocal conformation is confirmatory of accuracy in results; especially is this so since our investigations were completed and the paper nearly written before having noticed the following observations of others:—

Andral, in speaking of the diseases of the spleen, says that “the *splenic cells* are filled with *coagulated fibrin*, which, although it does not possess any distinct organization, yet enjoys perhaps a greater sum of vitality than the fibrous tissue which contains it, and consequently is more prone to become irritated and altered in its nutrition.”

The *splenic cells* of Andral are what we have denominated the oval *splenic bodies*, which terminate the *tubular glandules*. The *coagulated fibrin*, he speaks of in the *splenic cells* (oval splenic bodies), is made up of *fibrin cells* (organized by the tubular glandules) undergoing, in the oval splenic bodies, filamentous metamorphosis, or being developed into *fibrin filaments*. These fibrin cells are retained in the diverging capillaries of the oval splenic bodies, mostly until they are transformed into almost inconceivably fine fibrin filaments, when they pass on through the thin-walled capillaries of these bodies, and enter the venal extremities and form the cylindrical tunic which constitutes the outside blood stream.

Andral further states that “a very frequent cause of induration of the spleen appears to be protracted mechanical congestion, as that from disease of the liver, obstructing the circulation through the vena portæ, from disease of the heart, from ague, &c. In induration of the spleen, the concrete blood in the cells is usually dense, so that the viscus cuts and appears like liver.

“Induration is sometimes attended with a deficiency of colouring matter in the concrete blood of the cells. This deficiency may exist, 1st, in detached points, and the organ then presents a beautiful mottled appearance; and, 2d, the discoloration may form masses variable in size, of a reddish-yellow colour, finally becoming pale *like fibrin*, with a structure obscurely granular, occasioned by the moulds of splenic cells. These tumours appear to be nothing more than the fibrin of the blood undergoing changes similar to what we see in the veins.”

We can readily see how it is that the fibrin filament, developing from the fibrin cells in the oval splenic bodies, may become interwoven and solidified by any cause, such as congestion from hepatic obstructions, which prevents the free passage of the blood and rapidly-forming blood products through the spleen. We can readily understand how it is that,

under such circumstances, the cut surface of the spleen should assume a mottled appearance at death and for a reasonable time thereafter.¹

In the oval splenic bodies, where the constantly entering and developing fibrin cells are being transformed into fibrin filaments, we would have a light-coloured mass of almost pure partially organized fibrin and fibrin cells; while in places made up of congested capillaries filled with blood, we would have a red patch of a softer consistence. The obscurely granular appearance arises from the minute cells and globules from the interior of the fibrin cells: a portion of which are set at liberty, and adhere to the filaments of fibrin when these fibrin cells have undergone the filamentous metamorphoses. Enlargement, according to Andral, "depends either on the blood deposited by the arteries not being removed in sufficient quantity by the veins, whence there is enlargement by mere congestion, or the blood being once deposited, and having become endowed with life, acquires the faculty of nourishing itself by intussusception, whence there is enlargement by hypertrophy. Diminution of the spleen depends upon some defect of nutrition."

The peculiar functions of this gland, as set forth in the preceding pages, of organizing fibrin cells and filaments, and other blood products, explains why it is one so subject to enlargement and induration, by any cause, which prevents free circulation through it while its organizing processes are actively going on.

Softening and induration of this organ evidently depend upon a change in the constitution of the blood or coagulated fibrin which fills the splenic cells. In softening, the blood is so thin as to admit of being thoroughly washed out of the cellular parenchyma. Sometimes it is perfectly fluid, and gives an obscure feeling of fluctuation. Softening may be attended with diminution or enlargement of volume—the latter is common after protracted typhoid fevers. Analogy leads us to believe that inflammation may be one of the causes of softening, but a more frequent cause probably is an *alteration of the whole mass of the blood, since it is principally in typhoid fevers, scurvy, &c., that softening is observed.* (Hope's *Princ. and Illust. of Morb. Anat.*) The cause of the change in the blood arises from deranged function of the parent fibrin cells in the arterial extremities. We can readily perceive how it is, that the blood of the body may become thin (deficient in fibrin) as soon as the functions of the spleen are partially or wholly suspended. This being the gland which organizes fibrin more

¹ As an evidence that these are cell products undergoing morphological changes, and are in transit and not connected at all with the elements of the spleen, we here refer to the simple fact that, in a few days after death, even when the spleen is removed from the body at death and preserved carefully in alcohol, these cell products of the so-called *splenic cells* (*oval splenic bodies*) have become entirely transformed into highly transparent filaments, and entirely disappeared. This would not be the case with any fixed organic elements of the organ.

largely than any other, if its functions in this respect be suspended by the blocking up of the tubular glandules and oval splenic bodies with partially organized fibrin, one great source of this product would be cut off from the blood. The fibrin already in the blood would become deposited in the tissues, and one important source being cut off, the blood would become necessarily thin and deficient in fibrin or clot.

Whenever the whole mass of the blood of the body becomes very abnormally thin, we may look to the spleen for the primary lesion; that is, for the obstruction or other derangement of the fibrin manufacturing glandules of this organ.

Alex. Tweedie, in his work on *Diseases of the Digestive, Urinary, and Uterine Organs*, says: "Our ignorance of the function, or functions which the spleen is destined to perform in the animal economy, supersedes any attempt to apply to its diseases the distinction into those that are functional and those that are structural. We may, therefore, turn our attention at once to the structural affections of this organ, including those in which there is simply a disturbance of its circulation, and those in which its nutritive secretion is morbid in respect to the quantity or the quality of its products.

These remarks can no longer be applicable to this gland, since now its functions and structure are perhaps more thoroughly made out than those of any other gland in the human organism. In all those diseases where either the fibrin or red globules of the blood are abnormal in quantity or condition, the pathological lesions or derangement will be better understood, the diagnosis more satisfactory, and the treatment may be reasonably expected to afford more satisfactory results. These subjects will be all considered in detail, in another paper, *On the Pathology, Symptoms, and Treatment of Diseases which are either the Consequence or the Cause of Splenic Lesions*.

Some of the interesting symptoms of diseases of the spleen, as given by Dr. Twedie, are: "*Depression of spirits, torpor of mind, inactivity of body, with much muscular debility; deadly paleness, or a yellowish hue, tending more to black or green than in diseases of the liver; great liability to hemorrhage from various regions of the body, to dropsy, to dysentery, and to ulcers of the legs.*"

The spleen is liable to take on a morbid condition in continued fevers, as well as in intermittents. Diseases of the head, stomach, and liver are liable to be accompanied by diseases of the spleen. *The spleen is more liable to be affected with disease in damp, marshy localities than in other situations. In intermittent fevers there is a diminution of red globules and fibrin. Softening and the breaking down of the spleen is common in intermittent and continued fevers, in scurvy, and in some varieties of malignant dysentery.*

Here we have symptoms and lesions of the spleen concisely stated, which are of great interest and value in this connection. By understanding the true functions of this gland, they are all readily traceable to their true cause. The depression of spirits and torpor of mind may arise from a defective or suppressed organization of nutrient nerve products; inactivity of body and muscular debility from a defective organization and supply of fibrinous materials for the support of the muscular tissue; the yellowish hue, tending to black or green from defective organization, and supply of red globules and their attendant products; the great liability to hemorrhage from various regions of the body, to dropsy, dysentery, &c.; from thinness or thickness of the blood, and a defective supply of its normal products, and a laxness of all the tissues.

The reason why the spleen is so liable to take on a morbid condition in continued fevers, as well as in intermittents, is that the exciting causes of these classes of diseases affect primarily the epithelial tissue, and have a tendency to derange those portions of it most, which are the most actively engaged in organizing nutrient products; the reason of which appears to be that the exciting causes exist alike in the materials we eat, drink, and inhale, and absorb through the skin.

The probable cause of the spleen being more subject to disease in damp marshy localities than in other situations, is that in the former districts miasmatic poisons impregnate more or less the air, the water, and the food. The diminution of fibrin and red globules in the blood of intermittent fevers is caused by a greater or less suppression of the splenic functions in this disease. The so frequent induration, softening, and breaking down of the spleen in intermittent fevers, scurvy, and in some varieties of malignant dysentery, arises from the peculiar functions of the gland and its liability to become deranged in structure and function, when exposed to the malarious and other exciting causes of these diseases.

Leucocytosis.—This is a disease of the lymphatics, and like leukæmia is indicated by an increase above the normal standard of the colourless corpuscles of the blood, and a decrease in the blood disks. It is distinguished from leukæmia by the colourless corpuscles being shrunken, shrivelled, small, and ragged, while in leukæmia they are plump, larger, and more perfectly spherical. In this disease the lymphatic glands are the organs implicated, while in leukæmia the spleen is the suffering part. Both diseases may be either functional or organic. They may occur singly or combined. The microscope alone can settle this question.

These investigations explain the pathology of this disease, as they do that of leukæmia. In another paper on the structure and functions of the lymphatics, it will be shown that these glands are analogous in structure and function to the spleen; the difference being merely that in the former *white blood circulates—while red blood circulates in the latter*. That in the former the tubular glandules are the arterial extremities of the lacteals,

and lymphatics in the lacteal and lymphatic glands. That in these glands these tubular glandules terminate in capillary vessels as in the spleen, and that the arterial capillary and venal vessels of the lymphatics have the same structure as the arteries, capillaries, and veins, that carry red blood.

Leukæmia of Virchow, or Leucocythæmia of Bennett.—This is a disease first carefully studied and named by *Virchow*.¹ It is characterized by a continually augmenting increase in the colourless blood corpuscles, and with this increase a diminution of the coloured blood disks. In the healthy blood there is about one colourless corpuscle to every 300 blood disks. In this disease, the former goes on increasing, and the latter diminishing till the colourless corpuscles equal and often exceed in numbers the red corpuscles. Virchow states that in the histories of all the known cases of the disease, we find it only once as yet recorded that the patient, after he had been for some time the subject of medical treatment, left the hospital considerably improved in health. In all the other cases the result was death.

The cases described present this remarkable peculiarity, that towards the close of life a genuine *hemorrhagic diathesis* is developed, and hemorrhage ensues from the nose and often in the brain and intestinal canal.

Virchow further says that upon investigating whence this curious change in the blood takes its origin, we find in the great majority of cases that it is a certain, definite organ, which presents itself over and over again with convincing constancy as the one essentially diseased; an organ which frequently, even at the outset of the malady, forms the chief object of the complaints and distress of the patients, namely, the *spleen*. In addition, a number of the lymphatic glands are very frequently diseased, but the affection of the spleen stands in the foreground.

The primary seat of this disease hence appears to be the *spleen*.

The symptoms of this disease in this connection are not without interest. They are briefly as follows: increase in colourless corpuscles of the blood and decrease in red globules; enlargement of the spleen; pale, waxy appearance of countenance; lips pallid; cellular tissue soft and pulpy; muscular and nervous debility, and torpor of mind and body. Towards the close of life there is a peculiar tendency to hemorrhage from both mucous and serous surfaces.

The interesting and important glandules and newly-discovered functions of the spleen, as determined by these investigations, throw valuable light upon this disease. The functions of the tubular glandules appear to be over active, while the fibrin cells organized by them are retarded to a greater or less extent in their metamorphosis into fibrin filaments and blood disks; hence results the deficiency in the coloured globules and fibrin, and the

¹ Dr. Bennett, of Edinburgh, has described a case, without naming it, in the Oct. No. 1845, of the Edinburgh Med. and Surg. Journal, which was about six weeks previous to Virchow's description of the disease. This should entitle him to the credit of its discovery.

resulting pale waxy hue and general torpor of mind and body, and the constant increase in the colourless corpuscles as the disease progresses.

Virchow says the spleen is a remarkably sensitive organ, which swells not only in intermittent and typhoid fevers, but also in most other processes in which noxious infectant matters have been freely taken up into the blood.

The spleen is enlarged in melanæmia. In this disease a condition exists somewhat allied with that of leukæmia; since we have in it to deal with elements which, like the colourless corpuscles in leukæmia, make their way from definite organs into the blood and circulate with it. Meckel found that in this disease the spleen was invariably enlarged and pervaded by black pigment, and he therefore ascribes the change in the blood to an absorption of coloured particles from the spleen. The pigmentary matter of this disease is believed to be developed in the spleen. The occurrence of the pigmentary matter in the blood is supposed to be always due to affections of this organ.

I have here briefly thrown together a condensed statement of my labours connected with the spleen, and have introduced only a small portion of the more important illustrations; yet enough, I trust, has been given to convey a tolerably clear idea of the subjects discussed and of the extent of the labours.

ART. II.—*Account of the Epidemic of Yellow Fever which visited Pensacola Navy Yard in the Summer and Autumn of 1863.* By B. F. GIBBS, M. D., Surgeon U. S. N.

It is not proposed in this article to write an elaborate essay upon a disease which has been known, as a malady most fatal to human life, for a hundred years. To scrutinize facts which have been exposed to the medical public in every manner best suited to determine the hidden mystery of the nature, cause, and treatment of the disease would be equally unprofitable; but it will not be amiss to offer a few facts collected on the field of pestilence, that may help to remove a prejudice or unveil a mystery.

It would be an easy matter to fill many pages with conflicting opinions regarding the origin and character of this dreadful disease. But after steadily probing the obscurities and combining the statements and facts selected from a thousand sources, all have been obliged to rest in the field of research dissatisfied with their incomplete and unsuccessful labours. Not as a theorist, but as a contributor of some observed facts, which I trust will be useful in themselves, as such, I offer the following observations:—

It is necessary to remember that the scene of this epidemic at Pensacola, Fla., was under the most complete military control. No ships entered the